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Kepone in bed sediments of the James River estuary

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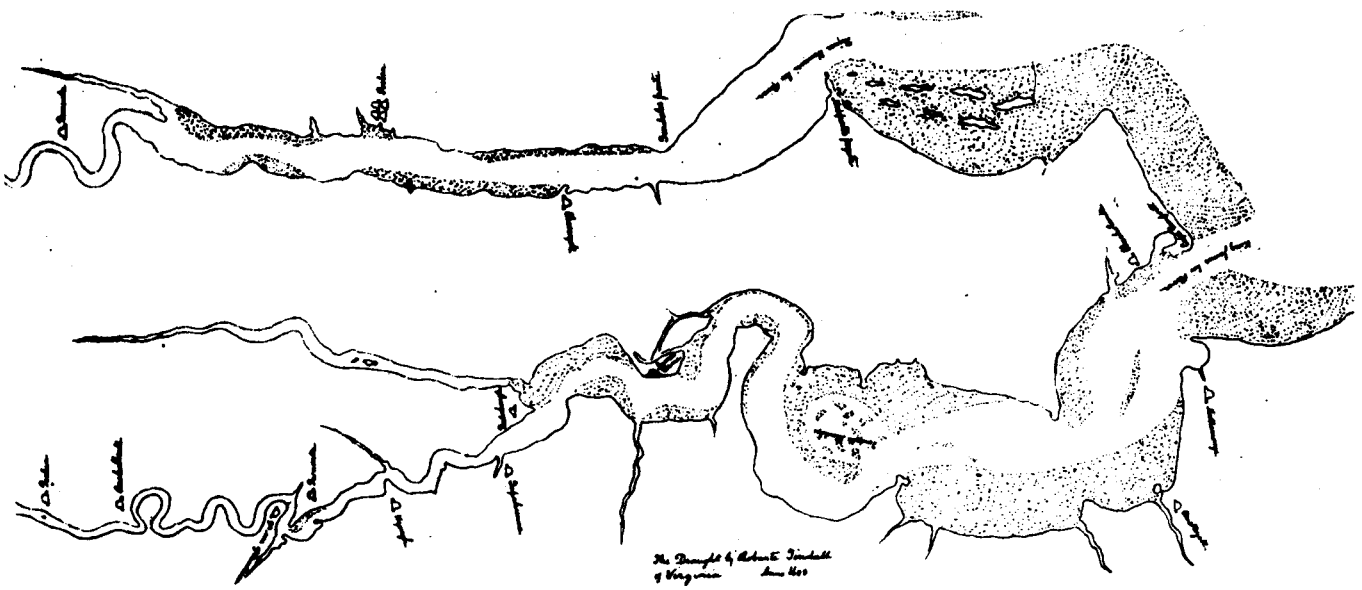
OF THE

JAMES RIVER ESTUARY



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KEPONE IN BED SEDIMENTS OF THE JAMES RIVER ESTUARY

Introduction

This report describes procedures and presents data concerning the concentrations of Kepone in bed sediments of the James River estuary, Virginia. Interpretation and data analysis are presented separately (Nichols and Trotman, 1977).

Purpose

Observations were planned to determine: (1) where Kepone accumulated in bed sediments, (2) what changes take place in the Kepone concentrations with time, and (3) how the Kepone concentrations vary with different sediment characteristics.

Sample Plan

Bed sediments were collected on quarterly cruises from December 1976 to July 1977. Stations were laid out from a point just upstream of Hopewell, Virginia, the Kepone source, to the lower Chesapeake Bay. Additionally, the zone just downstream of the Kepone source was sampled in October 1976, and the lower Chesapeake Bay was sampled in September 1977. Stations were positioned to sample major zones of sediment deposition, natural and dredged channels (> 4 m water depth), natural shoals (< 4 m water depth), and banks of dredged material.

Figures 1 and 2 give the station locations. Stations are numbered according to the distance in nautical miles upstream or downstream from Fort Wool at the mouth of Hampton Roads. A letter suffix indicates a second or third station within a one mile segment. Stations in lower Chesapeake Bay are designated by the prefix "C".

Field Procedures

Samples were collected from outboard runabouts. Stations were positioned by ranging, pelorus bearings and sextant angles on bouys and fixed objects including

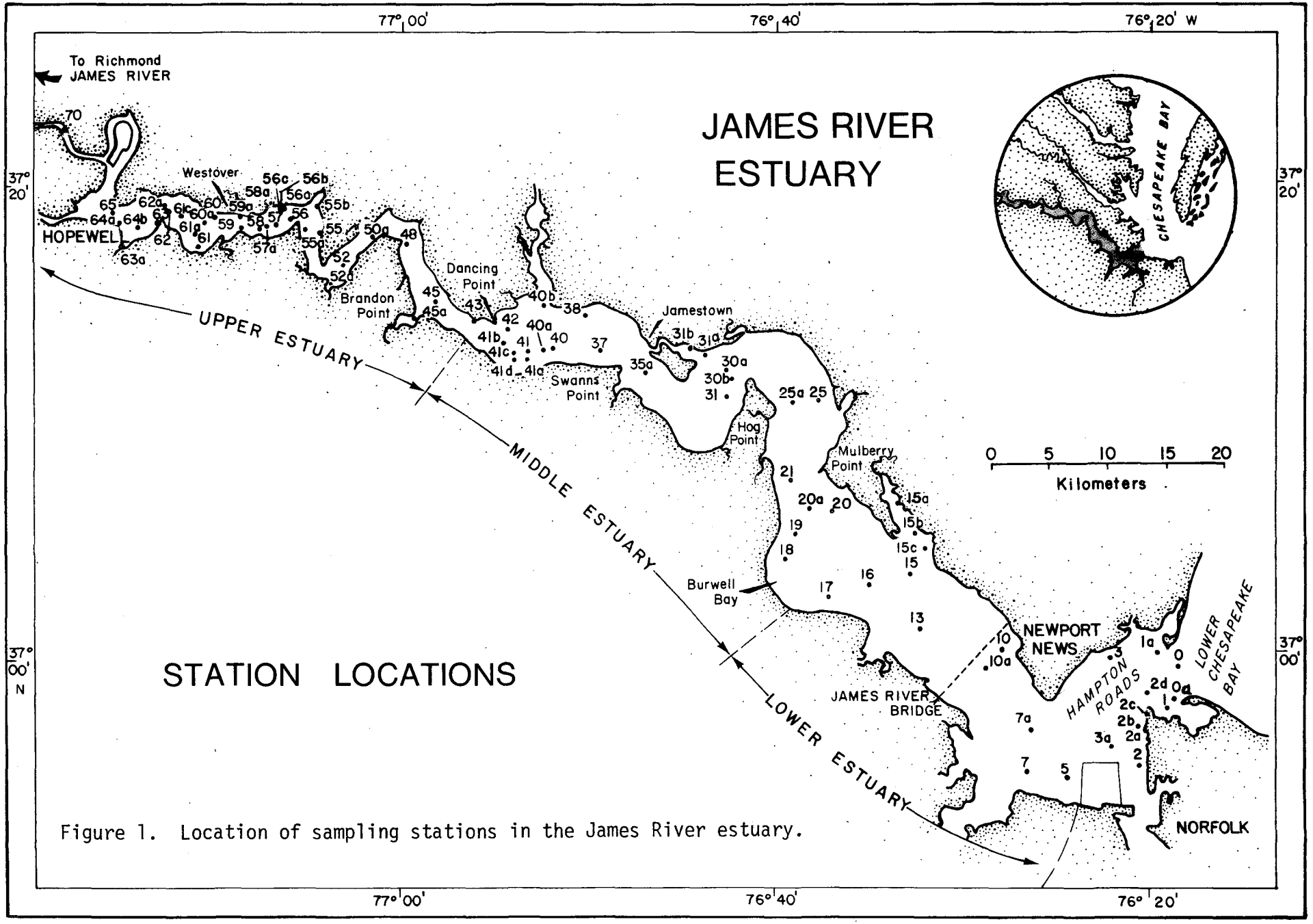

Figure 1. Location of sampling stations in the James River estuary.

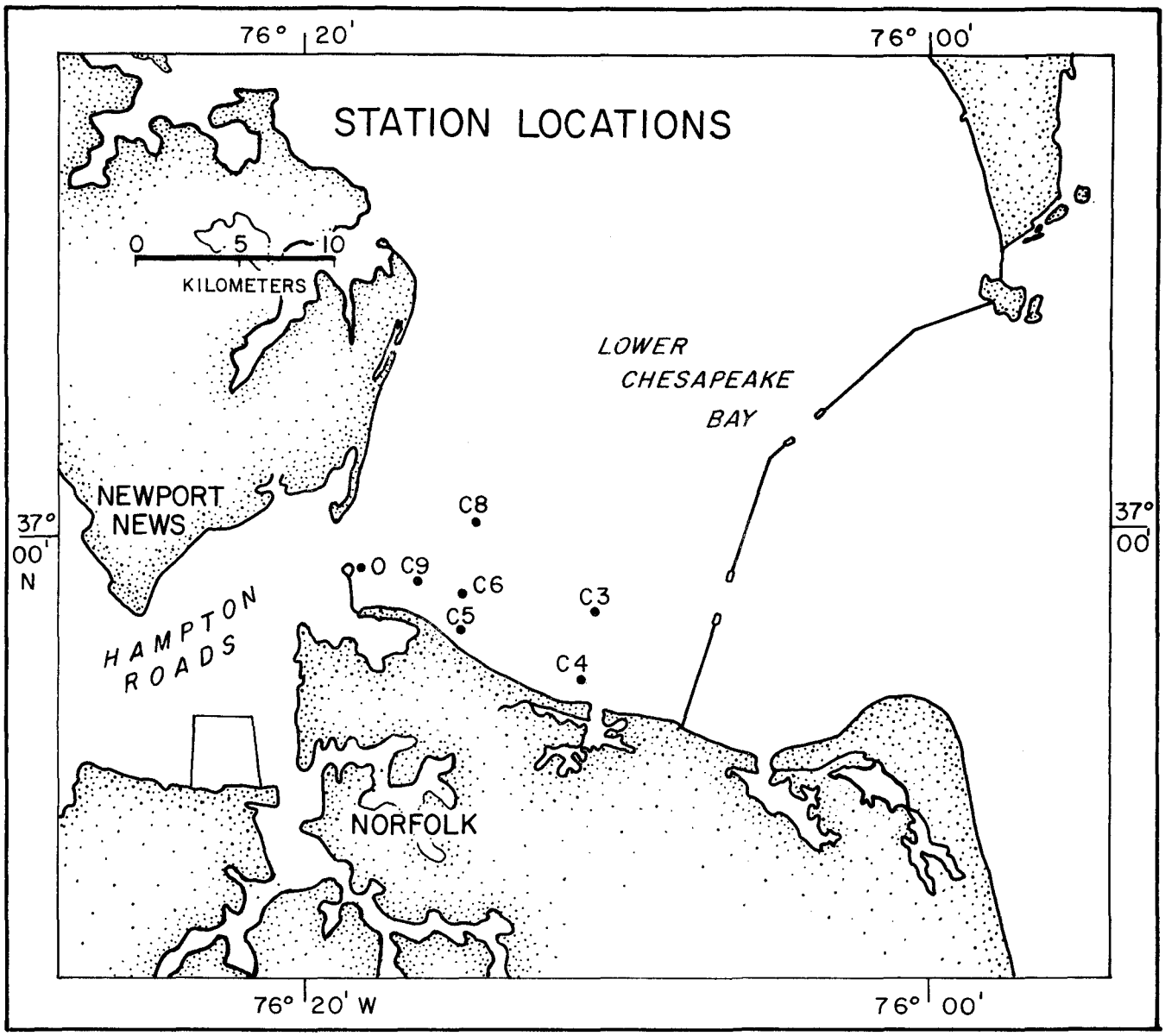

Figure 2. Location of sampling stations in the lower Chesapeake Bay, 30 September 1977.

landmarks. Water depths were determined by a fathometer or leadline. A total of 91 stations were occupied; 161 sediment samples and 25 cores were obtained.

Most sediment samples were collected with a light weight gravity core. However, where the core failed, a Petersen or Ponar grab, having a 0.05 m^2 bite area, was employed. The core consisted of a 7.6 cm (3.0 inch) O.D. acrylic or aluminum tube attached to a head containing a valve unit. Several cores were taken at some stations to obtain a sufficient amount of material for analyses. Once a core or grab was retrieved, the top 1.0 to 2.0 cm (31 to 62 ml) of soft sediment of fluid mud was scraped or sucked off with minimum disturbance. This layer is considered the dynamic or "active" part of the bed sediment that is subject to resuspension or movement by waves and currents.

The surface sediment was placed into glass jars which were pre-rinsed with pesticide grade acetone to avoid contamination. Samples were stored on ice in the field and in a laboratory cold room prior to analyses.

Laboratory Procedures

General. The bulk sample material was processed according to the scheme shown in Figure 3.

Initially the bulk sample material was mixed with a rotary propeller and aliquots of the slurry were withdrawn for analyses of Kepone concentration, particle size, water content, organic content (volatile solids), total carbon and carbonate content.

Kepone Analysis. Approximately 10 to 30 grams of sediment was dried, pulverized and mixed with a desiccant of 10 percent Quso - 90 percent anhydrous sodium sulfate using 2 parts of desiccant to 1 part sediment by weight. This mixture was extracted by exhaustive Soxhlet extraction with 1:1 diethyl ether: petroleum ether. The extract was cleaned by column chromatography utilizing activated florisil and two eluting solvents: (1) two percent methanol, four

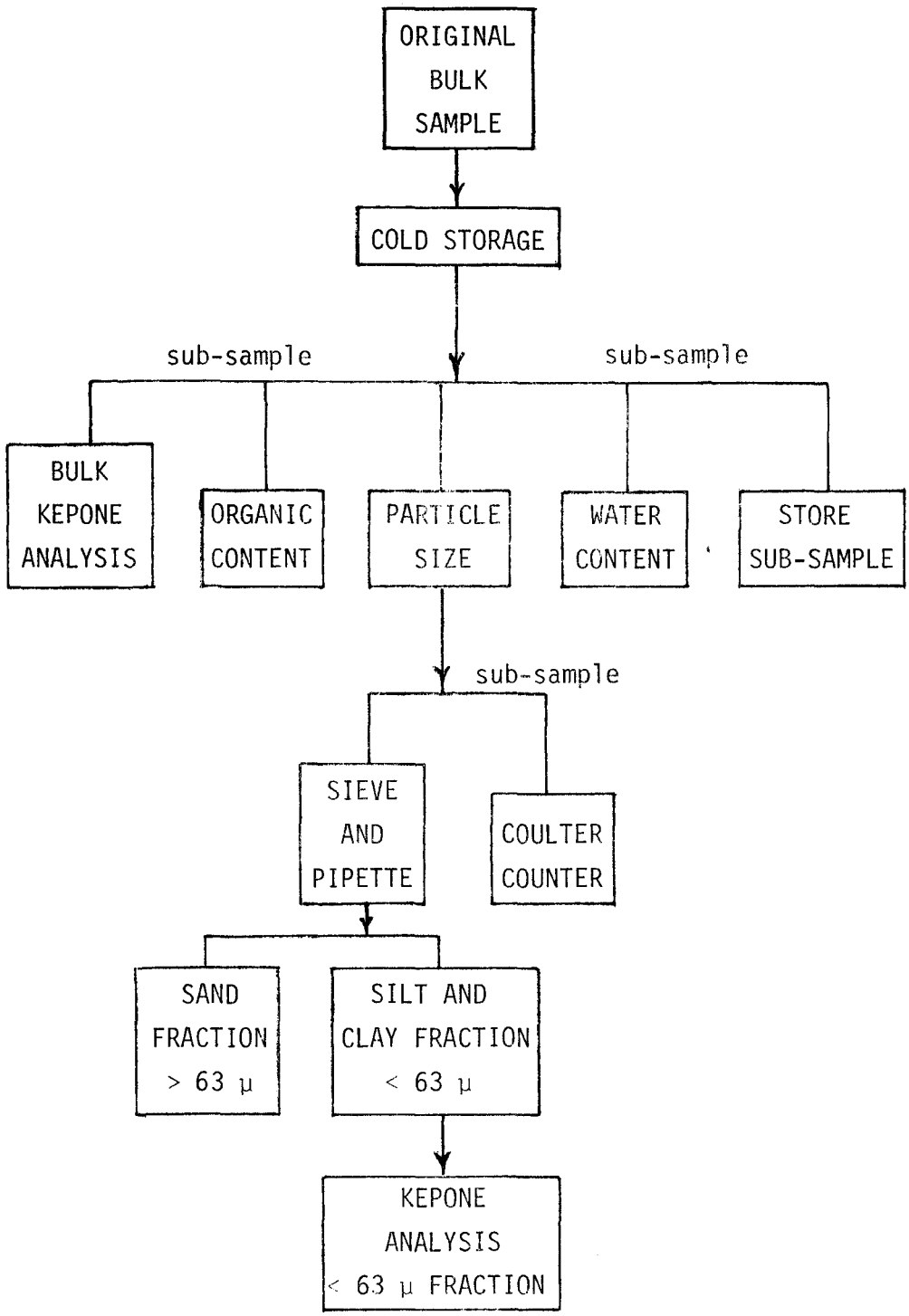

Figure 3. Scheme for processing of bulk sediment samples in the laboratory.

percent benzene, in normal hexane; and (2) one percent methanol, four percent benzene, two percent acetonitrile, in normal hexane. The Kepone contained in the second solvent was collected and quantified by electron captured gas chromatography. Kepone values are reported in parts per billion (Tables 1, 2, 3 and 4).

Particle Size Analysis. Particle size was determined by the sieve and pipette method of Folk (1968). Since four percent of calgon dispersant was shown to produce a significant reduction in Kepone concentration, samples were not disaggregated. One teaspoon of wet sediment was sieved through 63 μ mesh to collect the sand fraction. The remainder was pipetted at appropriate times and depths to determine the percent of silt and clay fractions. The sand, silt and clay percentages are expressed as weight percent (Table 2)

To examine the size characteristics in greater detail, the fine-grained portion (< 63 μ) of selected samples was analyzed in a model TA Coulter Counter. A one-tenth ml aliquot of well-mixed sediment slurry was diluted in 5 ml of distilled water and 0.5 ml of 4 percent calgon was added. The resultant mixture was stored for 24 hours and then remixed by mechanical agitation for 15 minutes prior to analysis at a 7 percent concentration index. Cumulative curves of particle size frequency were plotted, and the statistical parameters, mean, median and standard deviation were derived from relations of Inman (1952).

Special Experiment

To examine the affinity of Kepone for different particle sizes and organic matter, a special experiment was performed. Bulk surface sediment of fluid mud was obtained from Stations 18, 42, 63 and 63A representing sites downstream from the Kepone source. One-half liter aliquots from each sample were wet sieved with warm tap water through a nest of sieves having sizes of 125 μ, 105 μ, 88 μ and 63 μ. The remaining sediment, silt and clay that passed through the 63 μ sieve was collected in a 49 l (13 gal) carboy and further processed by settling. The water-

mud mixture was initially stirred and allowed to settled for time intervals corresponding to the particle sizes: 63 μ (4 ϕ), 16 μ (6 ϕ), 8 μ (7 ϕ) and 4 μ (8 ϕ) by Folk (1968). One-liter quantities were withdrawn from the carboys by siphoning at depths corresponding to the aforementioned particle sizes (Folk, 1968). The subsamples from each size group were then dried and analyzed for Kepone and for total carbon content. To avoid Kepone contamination from sample to sample throughout processing, containers, stirrers and pipettes were rinsed with acetone solvent. Because particle dispersant tends to adsorb Kepone, no dispersant was used. Resulting data are presented in Table 4.

Water Content and Density

Water content ω_c, is the ratio in percent of the weight of water in a given sediment mass, ω_w, to the weight of the oven-dried solid particles, ω_s (Dawson, 1959). Water content of bed sediments was determined gravimetrically by weight loss. Approximately 20 ml of sample, which was stored in aluminum cans sealed with tape, was weighed and oven-dried at 105°C for 24 hours. After cooling to room temperature, the samples were reweighed in a dehumidified room. The weight loss was taken as the weight of water in the sample and the percent water content was calculated according to the equation:

$$\omega_c = \frac{\omega_w}{\omega_s} \times 100$$

Bulk density of the sediment is defined as the weight per unit volume of the total sediment mass. This is derived from the water content data assuming a grain density of 2.70 using the relation:

$$\rho = \frac{2.70\ \omega t}{\omega_d + \omega_w}$$

where ω_t is the total wet sediment weight, ω_d is the dry sediment weight and ω_w is the weight of water. Data for water content and density are given in Table 2.

Organic Content

The organic content, or volatile solids, was determined gravimetrically by weight loss after combustion. Following procedures of the APHA (1971), samples were dried, weighed and heated at 600 to 650°C for one hour. They were then allowed to cool in a dessicator and subsequently reweighed. The loss-on-ignition gives an estimate of the organic content based on percent of the total dry weight. Because the values of the samples were initially much higher than anticipated, selected subsamples were rerun at 550 to 600°C for one hour and another set was rerun at 350 to 400°C for eight hours as recommended by Jackson (1958). The low temperature minimizes the effect of weight loss caused by oxidation of carbonate and dehydration of water bound to clay particles. Since the low combustion temperatures gave the best results, a correction curve was developed to adjust the values attained by high temperature combustion. Final values are expressed in weight percent, Table 2.

Total Carbon

Total carbon of bed sediments was determined by dry combustion in a Leco induction furnace. A dried, ground and weighed sample of 0.1 to 0.5 gm was placed in a ceramic crucible and combusted to about 1480°C in a stream of oxygen using tin and iron accelators. The carbon dioxide, a product of carbon combustion, was purified and passed into a ascarite trap. This was weighed seven minutes after the combustion temperature was reached. Percent total carbon was determined gravimetrically utilizing a standard regression curve based on acetanilide. Carbon values are expressed as weight in mg and weight percent of the total sample, Table 4.

Carbonate Content

The amount of carbonate, including shell debris, was determined by a Fisher Automatic Tritimeter Model 36 standardized with hydrochloric acid. About 2 g of dry weight of sample was stirred constantly while titrating to an alkalinity inflection point at pH 4.5. Titration was terminated when the automatic flow ceased for one minute. Weight percent of carbonate was calculated by the relation

$$\omega_t CO_3 = 0.5 \text{ (HCL molarity) (HCL volume) } \left(\frac{60.01 \text{ g } CO_3}{\text{mole } CO_3}\right)$$

Results

The distribution of Kepone concentrations presented in Figures 4 through 7 show that:

1. Kepone mainly accumulated in major zones of sediment deposition, in the middle estuary, i.e., the channel of Burwell Bay and channels and shoals of the Dancing Swann Point area.
2. Kepone accumulated locally in secondary zones of deposition, at tributary creek mouths and depressions just downstream of the source.
3. Concentrations vary considerably from station to station and with time at the same station.
4. Within limits of variation, concentrations show little change between December 1976 and July 1977.
5. Kepone near the source and in the middle estuary has an affinity for organic material while in the lower estuary it is associated with fine-grained sediment.
6. Kepone extends downward in the bed to more than 80 cm (Table 3). Contamination is generally deeper in zones of fast deposition, mainly in the shipping channel, than in zones of slow deposition on the shoals.

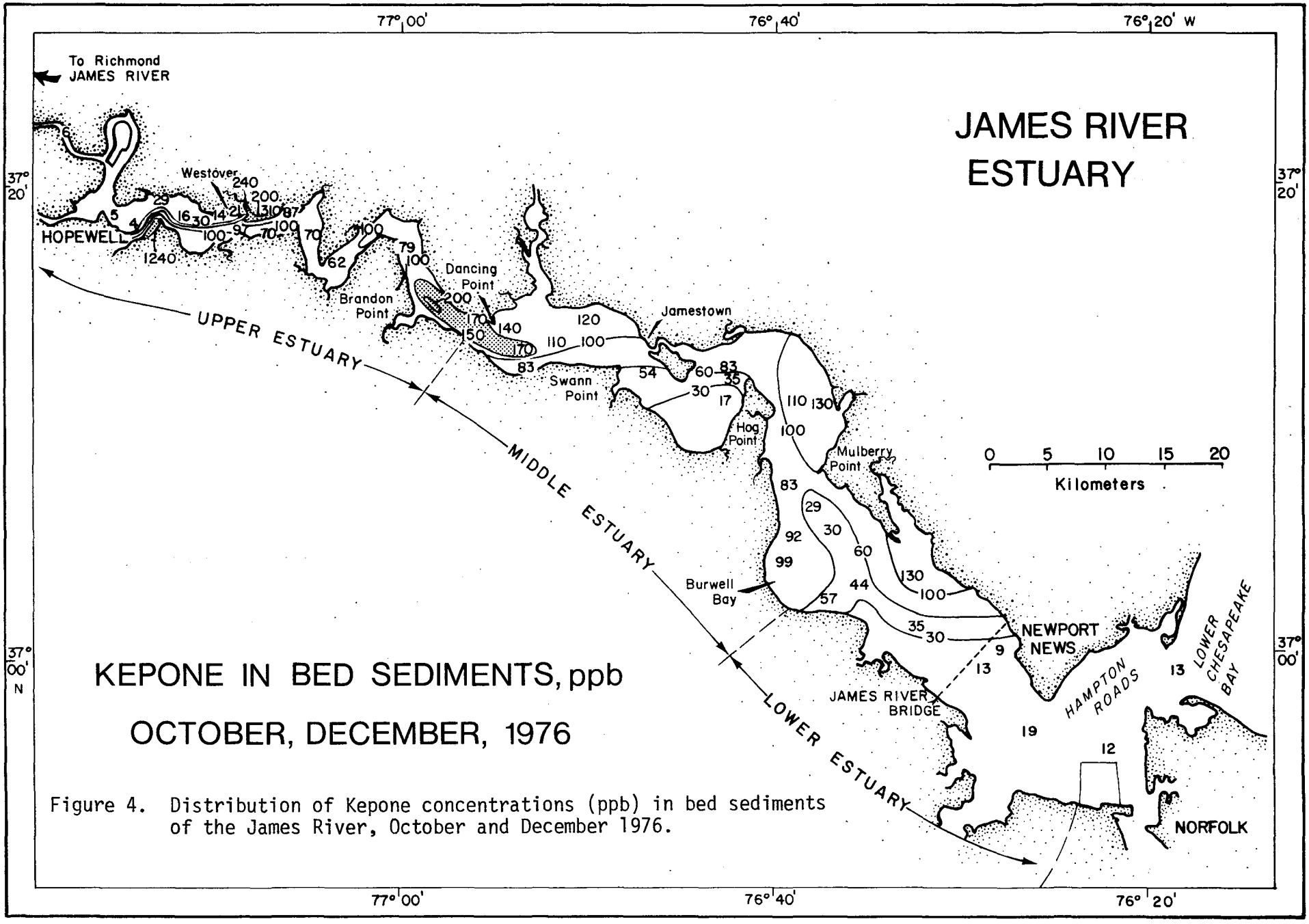

Figure 4. Distribution of Kepone concentrations (ppb) in bed sediments of the James River, October and December 1976.

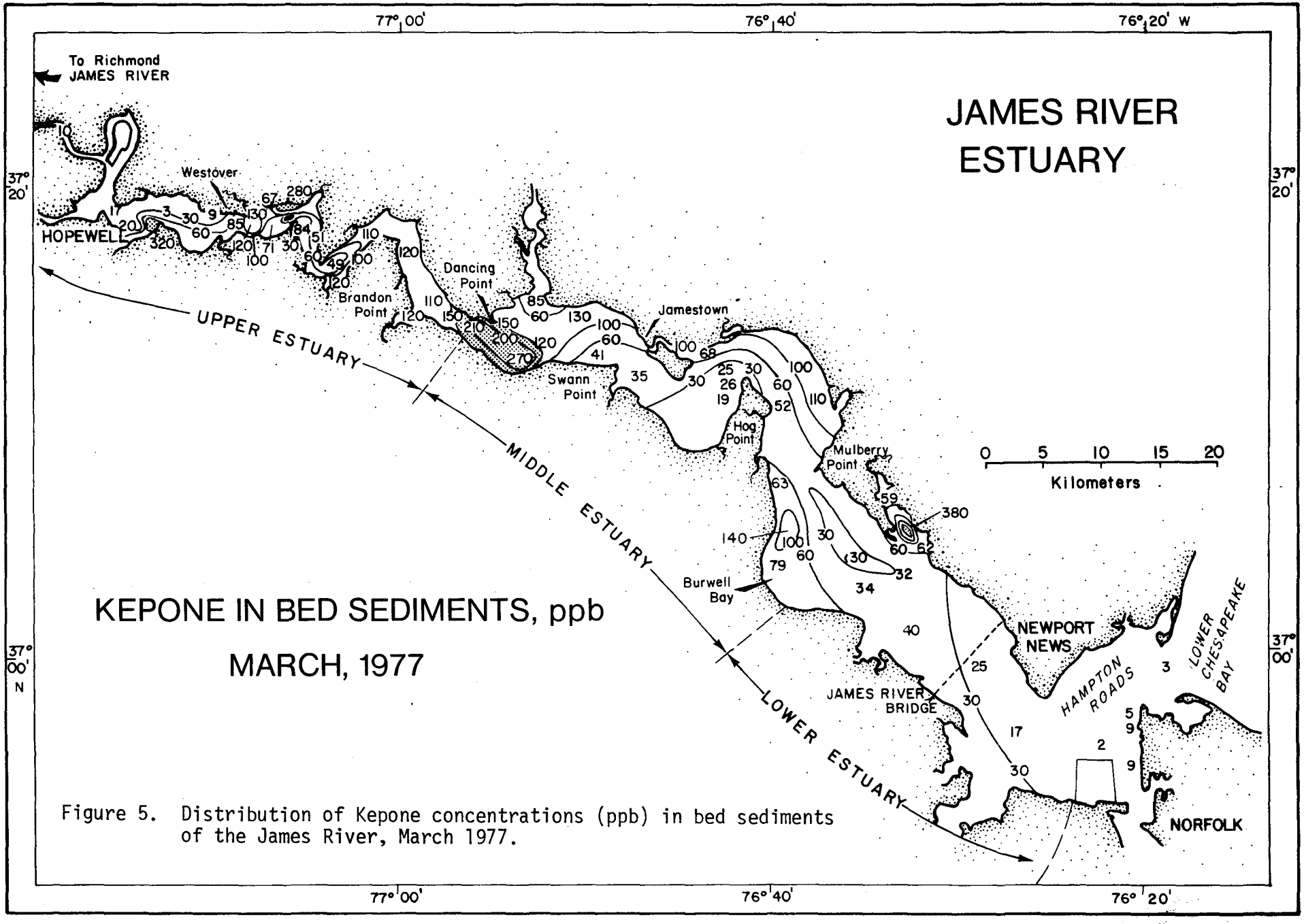

Figure 5. Distribution of Kepone concentrations (ppb) in bed sediments of the James River, March 1977.

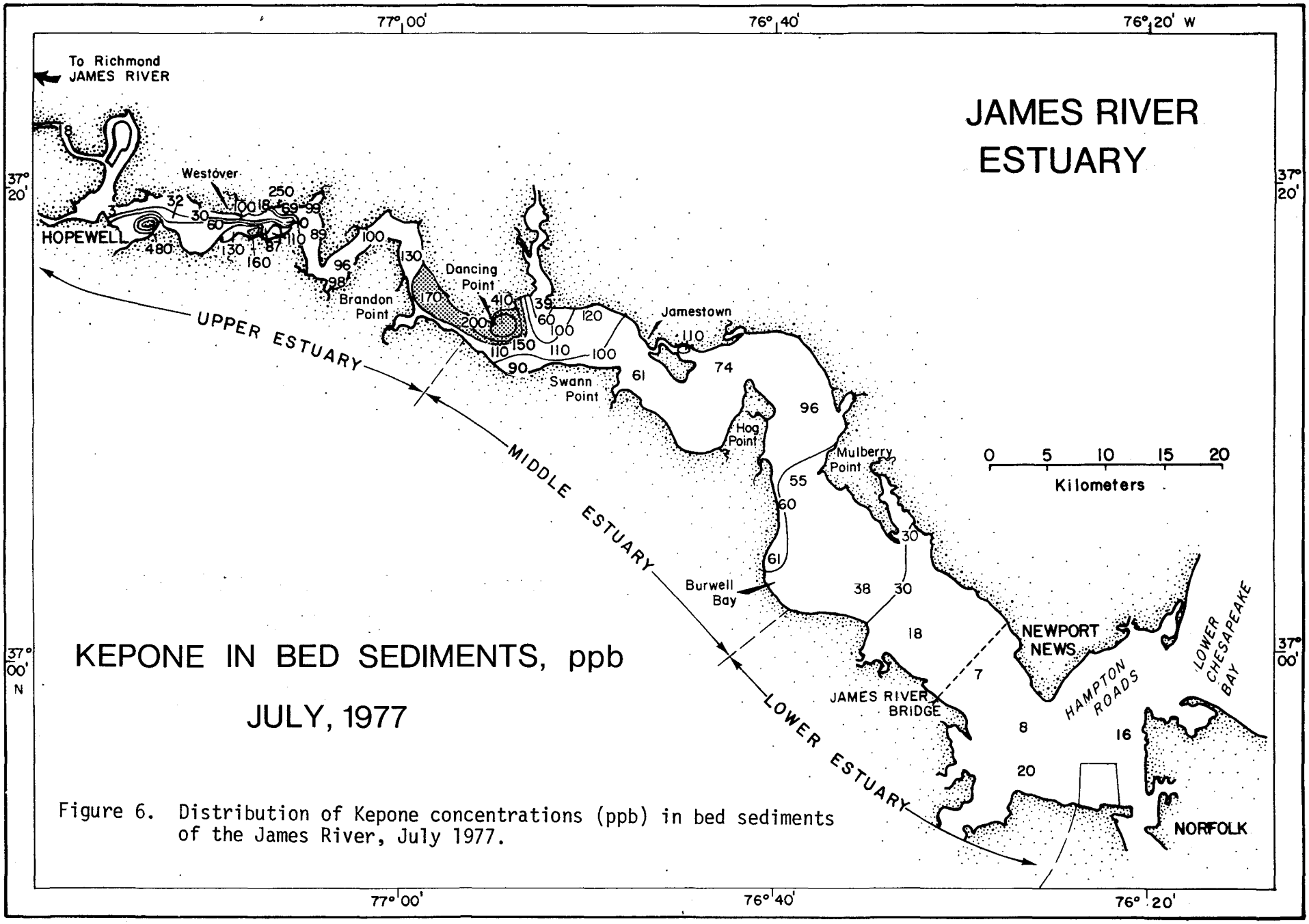

Figure 6. Distribution of Kepone concentrations (ppb) in bed sediments of the James River, July 1977.

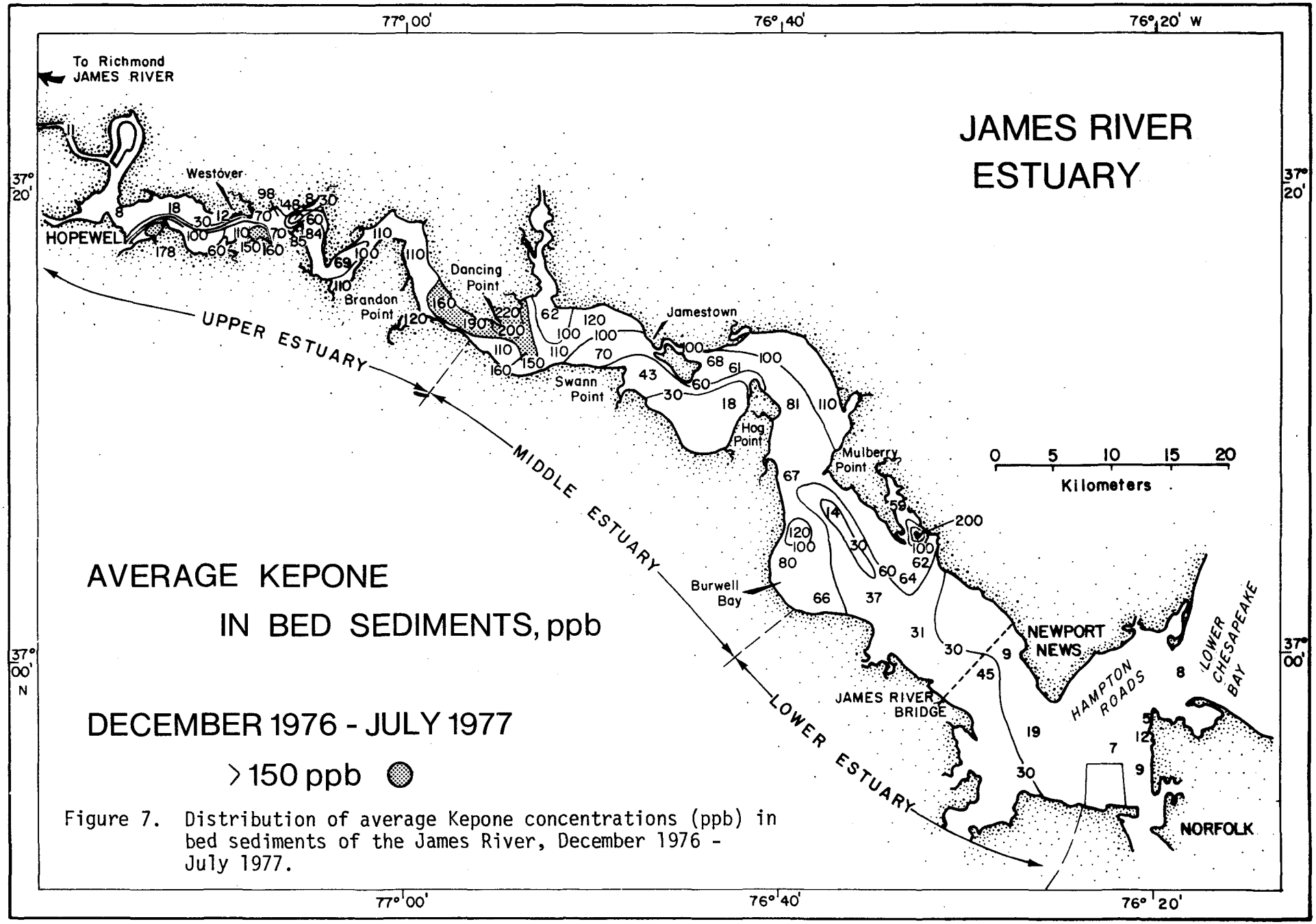

Figure 7. Distribution of average Kepone concentrations (ppb) in bed sediments of the James River, December 1976 - July 1977.

Acknowledgements

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Harold Slone	Assistant Marine Scientist
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Table 1. Station location data and Kepone concentrations for 29 October 1976.

Station	Date collected	Distance above mouth miles	Distance above mouth kilometers	Water Depth m	Kepone bulk ppb
56A	29 Oct 76	56.9	105.4	3.7	210
56C	29 Oct 76	57.0	105.6	3.7	250
57	29 Oct 76	57.2	106.0	7.9	78
57A	29 Oct 76	57.5	106.5	7.9	100
58A	29 Oct 76	58.0	107.4	1.5	240
59	29 Oct 76	58.6	108.6	7.9	97
59A	29 Oct 76	58.7	108.8	4.3	21
60A	29 Oct 76	60.2	111.6	7.9	
61C	29 Oct 76	61.3	113.6	7.9	16
62	29 Oct 76	62.1	115.1	7.9	
62A	29 Oct 76	62.4	115.6	2.1	29

Table 2. Station location data, Kepone concentrations and characteristics of bed sediments collected between 9 December 1976 and 30 September 1977.

Station	Date collected	Distance above mouth miles	Distance above mouth kilometers	Water depth m	Kepone bulk ppb	Kepone < 63μ ppb	% Sand	% Silt	% Clay	Particle size[1] (μ) Mean	Median	Standard deviation	% Water	Density g/cm³	% Organic content
0	16 Dec 76	0.0	0.0	4.0	13	N.Q.	97.5	0.0	2.5				21.4	2.08	0.1
3A	16 Dec 76	4.0	7.4	7.9	12	14	53.0	40.0	7.0	19.6	8.0	23.6	91.5	1.50	1.0
7A	16 Dec 76	6.5	12.0	5.8	19	14	13.8	72.0	14.2	36.0*	30.0*	34.5*	145	1.35	2.4
10	16 Dec 76	9.7	18.0	7.6	9	≤ 7	77.6	18.0	4.4	5.2	3.6	4.5	52.5	1.70	0.6
10A	16 Dec 76	9.7	18.0	5.2	13	≤ 4	10.4	67.0	22.6	37.0*	22.0*	40.0*	163	1.31	3.4
13	16 Dec 76	13.0	24.1	4.6	35	13	15.1	75.9	9.0	47.0*	35.0*	46.5*	154	1.33	3.0
15	15 Dec 76	14.9	27.6	2.7	130	120	3.2	91.0	5.8	13.7	12.2	10.1	118	1.41	5.6
16	15 Dec 76	16.0	29.6	7.3	44	31	37.9	50.7	11.4	42.0*	25.0*	45.5*	123	1.39	2.0
17	15 Dec 76	17.6	32.6	3.7	57	51	5.3	80.6	14.1	7.8	4.6	7.8	250	1.22	4.4
18	15 Dec 76	18.8	34.8	7.9	99	76	3.7	85.1	11.2	8.9*	5.9*	8.4*	278	1.20	5.2
20	15 Dec 76	20.0	37.1	5.8	25	85	79.2	16.4	4.4	19.6*	10.8*	18.6*	69.4	1.59	2.2
21	15 Dec 76	21.6	40.0	6.4	83	26	5.0	71.4	23.6	10.3	6.1	10.0	279	1.20	4.7
25	9 Dec 76	25.1	46.5	7.6	130	64	6.6	73.0	20.3	10.1	6.4	10.0	200	1.27	4.4
25A	9 Dec 76	25.0	46.3	4.3	110	55	10.5	66.6	22.9	7.8	5.2	7.4	142	1.35	4.0
31	9 Dec 76	31.8	58.9	3.4	≤ 17	N.Q.	4.1	66.9	29.0	5.4	3.8	4.8	172	1.30	4.3
35A	9 Dec 76	34.5	63.9	2.7	54	60	20.7	64.5	14.8	19.4*	9.5*	20.9*	166	1.31	4.6
38	14 Dec 76	38.1	70.6	4.0	120	66	6.4	75.2	18.4	10.3	6.9	9.4	252	1.22	7.6
40	14 Dec 76	39.3	72.8	4.3	110	88	9.4	76.1	14.5	7.3	4.5	7.1	173	1.30	4.8
43	14 Dec 76	43.2	80.0	6.4	170	110	2.3	77.2	20.5	9.0	6.5	8.0	183	1.28	5.3
45	14 Dec 76	45.0	83.4	5.5	200	140	5.8	87.8	6.3	17.1*	10.6*	15.6*	151	1.34	4.4
48	14 Dec 76	47.8	88.6	0.3	79	68	2.8	67.9	29.3	11.2	8.6	9.4	469	1.12	5.8
50A	14 Dec 76	50.3	93.2	5.5	120	97	7.8	73.2	19.0	9.6	7.1	7.9	188	1.28	4.9
52	14 Dec 76	52.0	96.4	6.1	62	94	35.8	44.9	19.3	8.8	5.9	7.9	95.4	1.48	3.0
55	14 Dec 76	55.1	102.1	6.4	70	36	36.9	36.6	26.5	10.1	7.9	8.2	244	1.08	5.2
56A	14 Dec 76	56.9	105.4	3.7	81	69	7.3	77.2	15.5	12.6	9.9	10.2	216	1.25	5.1
56C	14 Dec 76	57.0	105.6	3.7	210	130	23.8	71.2	5.0	14.7	12.4	12.1	113	1.42	4.5
57	14 Dec 76	57.2	106.0	7.9	75	20	21.4	70.0	8.6	16.5	13.4	14.0	176	1.30	4.6
57A	14 Dec 76	57.5	106.5	7.9	70	19	26.9	64.1	9.0	14.5	12.3	11.6	188	1.28	5.5
60	14 Dec 76	60.0	111.2	4.9	14	≤ 8	92.0	4.4	3.6	12.2	8.6	11.6	59.0	1.66	0.7
63	10 Dec 76	62.8	116.4	1.2	4540	1240	13.9	67.0	19.1	16.7	14.3	13.0	361	1.16	14.0
64B	10 Dec 76	63.6	117.9	0.3	≤ 4	21	82.1	7.0	10.9	9.2	6.4	8.4	44.4	1.77	0.4
65	10 Dec 76	65.0	120.4	6.4	≤ 5	≤ 2	5.0	83.0	12.0	15.1	12.7	12.8	95.3	1.48	3.2
70	10 Dec 76	69.9	129.5	2.7	≤ 6	≤ 6	5.1	67.7	27.2	11.9	12.8	7.4	332	1.17	6.2

[1]See last page of Table 2.

*See last page of Table 2.

Table 2, continued

Station	Date collected	Distance above mouth miles	Distance above mouth kilometers	Water depth m	Kepone bulk ppb	Kepone < 63μ ppb	% Sand	% Silt	% Clay	Particle size (μ) Mean	Median	Standard deviation	% Organic content
0	10 Mar 77	0.0	0.0	4.0	< 3		31.8	31.2	37.0				1.7
2	10 Mar 77	4.9	9.1	13.7	< 9		5.2	29.5	65.3				5.4
2A	10 Mar 77	3.2	5.9	10.1	< 9		4.4	42.1	53.5	6.6	5.9	5.0	4.2
2C	10 Mar 77	2.6	4.8	12.8	< 5		5.3	23.9	70.8				10.2
3A	10 Mar 77	4.0	7.4	7.9	< 2		62.2	15.9	21.9				0.8
7	10 Mar 77	7.5	13.9	4.9	30		10.4	41.6	48.0				3.5
7A	10 Mar 77	6.5	12.0	5.8	17		17.8	43.1	39.1				2.1
10A	10 Mar 77	9.7	18.0	5.2	25		17.2	29.1	53.7				3.7
13	10 Mar 77	13.0	24.1	4.6	40		14.5	32.4	53.1	6.6	4.4	6.2	4.4
15	10 Mar 77	14.9	27.6	2.7	32		4.0	85.7	10.3				5.5
15A	10 Mar 77	18.5	34.3	1.8	59		7.9	41.4	50.7	7.7	4.7	7.6	3.6
15B	10 Mar 77	16.0	29.6	1.2	380		10.9	27.3	61.8	12.4	8.7	10.0	3.6
15C	10 Mar 77	15.3	28.4	1.5	62		16.9	43.5	39.6	8.0	4.8	8.0	4.8
16	10 Mar 77	16.0	29.6	7.3	34		44.9	25.7	29.3	9.2	6.7	6.7	1.5
17	10 Mar 77	17.6	32.6	3.7	75		3.3	31.3	65.4				3.8
18	10 Mar 77	18.8	34.8	7.9	79		3.3	36.1	60.6				3.5
19	10 Mar 77	19.5	36.1	4.6	140		7.2	33.8	59.0				3.5
20	10 Mar 77	20.0	37.1	5.8	< 3		27.1	31.1	41.8				1.6
21	10 Mar 77	21.6	40.0	6.4	63		5.5	33.7	60.8				16.4
25	10 Mar 77	25.1	46.5	7.6	110		13.0	42.8	44.2				4.4
25A	10 Mar 77	25.0	46.3	4.3	52		5.9	80.8	13.3				2.4
30A	10 Mar 77	30.0	55.6	7.3	25								2.0
30B	10 Mar 77	30.0	55.6	3.7	26		77.3	9.7	13.0				1.8
31	10 Mar 77	31.8	58.9	3.4	19								5.3
31A	10 Mar 77	30.5	56.5	1.2	68		8.9	37.7	53.4	5.1	3.5	4.7	5.5
31B	10 Mar 77	31.0	57.4	0.9	100		2.0	79.3	18.7				5.2
35A	11 Mar 77	34.5	63.9	2.7	35								2.0
37	11 Mar 77	37.0	68.6	5.8	41		25.0	44.8	30.2				1.0
38	11 Mar 77	38.1	70.6	4.0	130		4.6	64.5	30.9				4.3
40	11 Mar 77	39.3	72.8	4.3	120		2.6	67.1	30.3				2.6
40B	11 Mar 77	40.7	75.4	2.4	85								
41A	11 Mar 77	41.3	76.5	2.1	270		0.7	84.1	15.2				2.5
43	11 Mar 77	43.2	80.0	6.4	210		0.5	93.4	6.1				5.5
45	11 Mar 77	45.0	83.4	5.5	110		1.3	67.3	31.4				4.0
45A	11 Mar 77	45.7	84.8	1.8	120		0.9	62.5	36.6				4.8
48	11 Mar 77	47.8	88.6	0.3	120		6.0	44.0	50.0				3.0
50A	11 Mar 77	50.3	93.2	5.5	110		9.3	47.8	42.9				3.7
52	11 Mar 77	52.0	96.4	6.1	49		13.1	33.5	53.4				1.5
52A	15 Mar 77	52.5	97.3	0.3	120		5.9	40.6	53.5				4.3
55	11 Mar 77	55.1	102.1	6.4	51								3.4
55A	15 Mar 77	55.2	102.3	3.0	84		7.2	0.8	92.0				3.5
56	11 Mar 77	56.6	104.9	7.3	5		78.1	6.3	15.6				0.5
56A	11 Mar 77	56.9	105.4	3.7	280		5.2	69.5	25.3				5.2
56C	11 Mar 77	57.0	105.6	3.7	67		41.2	41.9	16.9				1.2
57	11 Mar 77	57.2	106.0	7.9	71		19.1	60.5	20.4				2.6
58A	15 Mar 77	58.0	107.4	1.5	130		11.0	57.4	31.6	7.9	5.5	7.3	3.5
59	15 Mar 77	58.6	108.6	7.9	85		40.5	32.9	26.6				3.2
60	15 Mar 77	60.0	111.2	4.9	9		74.4	14.8	10.8	5.7	3.8	5.2	0.3
62	15 Mar 77	62.1	115.1	7.9	< 3		2.7	66.6	30.7				2.7
63	15 Mar 77	62.8	116.4	1.2	320		65.3	21.3	13.4				0.5
64B	15 Mar 77	63.6	117.9	0.3	20		63.0	22.0	15.0				0.3
65	15 Mar 77	65.0	120.4	6.4	17					11.3	7.4	11.3	2.0
70	15 Mar 77	69.9	129.5	2.7	10		40.1	40.5	19.4				4.7

Table 2, continued

Station	Date collected	Distance above mouth miles	Distance above mouth kilometers	Water depth m	Kepone bulk ppb	Kepone < 63μ ppb	% Sand	% Silt	% Clay	% Organic content
2A	18 Jul 77	3.2	5.9	10.1	16		4.0	25.8	70.2	3.1
7	18 Jul 77	7.5	13.9	4.9	20		4.6	21.0	74.4	2.9
7A	18 Jul 77	6.5	12.0	5.8	≤ 8		8.4	26.6	65.0	2.9
10A	18 Jul 77	9.7	18.0	5.2	7		5.2	25.4	69.4	2.8
13	18 Jul 77	13.0	24.1	4.6	18		8.5	13.6	77.9	2.2
15	18 Jul 77	14.9	27.6	2.7	30		8.9	10.3	80.8	3.2
15B	18 Jul 77	16.0	29.6	1.2	30		15.4	13.1	71.5	1.9
16	18 Jul 77	16.0	29.6	7.3	38		14.7	6.3	79.0	1.9
18	18 Jul 77	18.8	34.8	7.9	61		5.5	9.9	84.6	5.9
21	29 Jul 77	21.6	40.0	6.4	55		8.0	33.7	58.3	5.6
25	29 Jul 77	25.1	46.5	7.6	96		9.0	31.9	59.1	4.7
30A	29 Jul 77	30.0	55.6	7.3	74		12.9	36.5	50.6	3.4
31B	29 Jul 77	31.0	57.4	0.9	110		6.8	35.6	57.7	5.9
35A	29 Jul 77	34.5	63.9	2.7	61		9.5	23.0	67.5	4.7
37	29 Jul 77	37.0	68.6	5.8	100		4.2	28.9	66.9	6.1
38	29 Jul 77	38.1	70.6	4.0	120		7.2	39.6	53.2	6.0
40	29 Jul 77	39.3	72.8	4.3	110		7.3	33.8	59.0	5.2
40B	29 Jul 77	40.7	75.4	2.4	39		38.3	21.4	40.3	1.1
41A	29 Jul 77	41.3	76.5	2.1	90		4.4	35.9	59.6	5.6
41B	29 Jul 77	42.2	78.2	5.8	110		5.0	33.9	61.1	5.7
42	29 Jul 77	41.9	77.6	2.7	410		5.5	49.0	45.5	6.0
43	15 Jul 77	43.2	80.0	6.4	200		3.2	29.7	67.1	7.1
45	15 Jul 77	45.0	83.4	5.5	170		2.7	27.6	69.7	4.9
48	15 Jul 77	47.8	88.6	0.3	130		12.1	27.0	60.9	10.5
50A	15 Jul 77	50.3	93.2	5.5	100		3.3	24.2	72.5	5.8
52	15 Jul 77	52.0	96.4	6.1	96		15.5	15.4	69.1	3.9
52A	15 Jul 77	52.5	97.3	0.3	98		4.8	27.3	67.9	7.0
55	15 Jul 77	55.1	102.1	6.4	89		4.6	20.3	75.1	5.3
55B	15 Jul 77	56.0	103.8	0.6	99		4.9	20.2	74.9	6.1
56	15 Jul 77	56.6	104.9	7.3	10		50.4	1.3	48.3	0.8
56A	13 Jul 77	56.9	105.4	3.7	69		6.3	38.7	55.0	4.7
56C	13 Jul 77	57.0	105.6	3.7	18		24.2	33.8	42.0	2.7
57	13 Jul 77	57.2	106.0	7.9	110		11.6	28.1	60.3	4.7
57A	13 Jul 77	57.5	106.5	7.9	87		7.2	29.9	62.9	5.4
58	13 Jul 77	58.0	107.5	7.3	160		1.8	45.4	52.8	5.3
58A	15 Jul 77	58.0	107.4	1.5	11		71.5	4.2	24.3	0.4
59	13 Jul 77	58.6	108.6	7.9	130		5.4	30.8	63.8	2.5
62	13 Jul 77	62.1	115.1	7.9	32		14.7	38.7	46.6	3.2
63	13 Jul 77	62.8	116.4	1.2	480		11.1	37.3	51.6	7.6
65	13 Jul 77	65.0	120.4	6.4	3		52.7	18.4	28.9	2.5
70	13 Jul 77	69.9	129.5	2.7	18		30.5	23.2	46.3	7.1

Table 2, continued

Station	Date collected	Distance above mouth miles	Distance above mouth kilometers	Water depth m	Kepone bulk ppb
0	29 Sep 77	0.0	0.0	4.0	< 10
0A	29 Sep 77	0.6	1.1	1.8	< 10
1	29 Sep 77	1.2	2.0	3.0	< 10
1A	29 Sep 77	0.4	0.7	1.2	< 10
2	29 Sep 77	4.9	9.1	13.7	< 10
2A	29 Sep 77	3.2	5.9	10.1	< 10
2B	29 Sep 77	3.0	5.6	13.7	< 10
2C	29 Sep 77	2.6	4.8	12.8	< 10
3	29 Sep 77	2.0	3.7	3.0	< 10
3A	29 Sep 77	4.0	7.4	7.9	< 10
5	29 Sep 77	6.7	12.4	3.0	< 10
6	29 Sep 77	6.2	11.5	7.6	< 10
C3	30 Sep 77	-6.7	-12.4	7.0	< 10
C4	30 Sep 77	-6.9	-12.7	7.9	< 10
C5	30 Sep 77	-3.3	- 6.2	7.3	< 10
C6	30 Sep 77	-3.1	- 5.7	6.4	< 10
C8	30 Sep 77	-3.7	- 6.9	8.5	< 10
C9	30 Sep 77	-1.8	- 3.4	4.9	17

Notes for Table 2:

[1]Unstarred samples run with 30μ and 140μ aperture tubes in the Coulter Counter.

*Indicates that 30μ, 140μ, and 280μ aperture tubes were used in the Coulter Counter.

N.Q. is non-quantifiable.

Table 3. Station location data, Kepone concentrations and characteristics of bed sediments from cores collected between 9 December 1976 and 18 September 1978.

Station	Station classification[1]	Date collected	Distance above mouth miles	Distance above mouth kilometers	Water depth m	Depth below sediment surface cm	Kepone bulk ppb	Kepone < 63μ ppb	Particle size (μ) Mean	Median	Standard deviation	% Organic content
18	NCF	18 Sep 78	18.8	34.8	7.9	0-1	70					
						12-13	150					
						20-21	100					
						30-31	50					
19	NCF	15 Dec 76	19.5	36.1	4.6	0-1	92	100	10.2	6.9	9.4	4.4
						10-11	170	100	14.4	9.5	14.1	4.5
						20-21	72	41	12.9	9.4	12.0	
						30-31	110					5.3
						40-41	N.D.					
						60-61	< 5					
20A	NCF	17 May 78	20.5	38.0	4.6	0-1	< 10					
						20-21	< 10					
						40-41	< 10					
21	NCF	10 Mar 77	21.6	40.0	6.4	0-1	60					
						10-11	15					
						20-21	62					
						30-31	65					
21	NCF	18 Sep 78	21.6	40.0	6.4	0-1	160					
						12-13	60					
						20-21	40					
						30-31	50					
25A	NS	15 Nov 77	25.0	46.3	4.3	0-1	56					
						10-11	< 10					
						20-21	< 10					
						40-41	< 10					
30A	DCF	9 Dec 76	30.0	55.6	7.3	0-1	83	39	10.4	6.4	10.5	5.0
						30-31	220	140	9.5	7.0	8.6	5.3
						60-61	300	250	11.8	7.1	12.0	4.8
						81-82	290					
30B	DS	9 Dec 76	30.0	55.6	3.7	0-1	35	28	12.7	7.9	13.0	2.2
						30-31	25	83	9.8	5.5	10.3	4.6
						60-61	< 3	≤ 5	6.5	4.3	6.2	4.5
40A	DCF	18 Sep 78	40.3	74.7	7.3	0-1	40					
						20-21	70					
						39-40	70					
40B	NS	11 Mar 77	40.7	75.4	2.4	0-1	82					
						10-11	140					
						20-21	530					
						30-31	170					
						40-41	150					
						60-61	< 10					
41	DCF	14 Dec 76	41.1	76.2	7.3	0-1	170	150	14.1	11.1	12.6	4.4
						30-31	180	120	8.9	6.7	8.0	4.3
						40-41	180					
						47-48	< 7	51	9.7	7.2	8.8	4.4
41A	DS	14 Dec 76	41.3	76.5	2.1	0-1	83	54	12.1	9.6	10.6	5.5
						30-31	62	55	12.5	9.7	10.7	4.5
						60-61	< 4	≤ 4	10.1	7.4	9.2	4.3

[1]See last page of Table 3.

Table 3, continued

Station	Station classification[1]	Date collected	Distance above mouth miles	Distance above mouth kilometers	Water depth m	Depth below sediment surface cm	Kepone bulk ppb	Kepone < 63μ ppb	Particle size (μ) Mean	Particle size (μ) Median	Particle size (μ) Standard deviation	% Organic content
41C	DCF	1 Nov 77	41.7	77.3	7.3	0-1	39					
						10-11	68					
						25-26	100					
						40-41	120					
						52-53	255					
41D	DS	1 Nov 77	41.7	77.3	1.8	0-1	98					
						30-31	< 11					
						60-61	< 11					
42	NS	14 Dec 76	41.9	77.6	2.7	0-1	140	120	11.0	9.1	9.5	5.2
						5-6	850					
						10-11	550	410	13.6	11.3	11.8	4.7
						20-21	240	170	11.0	9.1	9.2	5.2
						30-31	62					
						40-41	< 5					
						60-61	< 5					
42	NS	11 Mar 77	41.9	77.6	2.7	0-1	150					
						10-11	130					
						20-21	260					
						30-31	< 10					
						40-41	< 10					
						58-59	< 10					
45	NCF	1 Nov 77	45.0	83.4	5.5	0-1	100					
						10-11	140					
						20-21	470					
						30-31	150					
						40-41	94					
56B	DS	13 Jul 77	57.0	105.6	3.7	10-13	250					1.9
						37-40	290					2.5
						50-53	195					1.6
						57-60	180					
						100-103	200					
						110-113						2.0
57A	DCF	4 Nov 77	57.5	106.5	7.9	0-1	19					
						10-11	< 10					
						20-21	67					
						40-41	< 10					
						60-61	< 10					
57A	DCF	2 Aug 78	57.5	106.5	7.9	0-2	40					
						20-21	20					
						40-41	50					
						60-61	60					
						67-68	50					
58	DCF	11 Mar 77	58.0	107.5	7.3	0-1	120					
						15-16	210					
						27-28	150					
61	NS	4 Nov 77	60.9	112.8	0.6	0-1	220					
						10-11	< 10					
						20-21	< 10					
61A	NCF	4 Nov 77	60.8	112.7	6.4	0-1	73					
						5-6	370					
						10-11	930					
						20-21	300					
						25-26	3120					
						30-31	1540					

Table 3, continued

Station	Station classification[1]	Date collected	Distance above mouth miles	Distance above mouth kilometers	Water depth m	Depth below sediment surface cm	Kepone bulk ppb	Kepone < 63μ ppb	Particle size (μ) Mean	Median	Standard deviation	% Organic content
63	NPS	4 Nov 77	62.8	116.4	1.2	0-1	130					
						10-11	< 10					
						20-21	< 10					
						30-31	< 10					
63A	NPS	4 Nov 77	64.5	119.5	0.2	0-1	17					
						38-39	< 10					

Notes for Table 3:

[1]Station classification

NCF: Natural channel fill
DCF: Dredged channel fill
NS: Natural shoal
DS: Dredge spoil
NPS: Near point source

N.D. is non-detectable.

Table 4. Sediment and Kepone data for special experiment; for details see text.

Station	Date collected	Size fraction	% Weight[1]	Kepone ppb	Kepone ng	% Kepone[1]	Carbon mg	% Total carbon[2]	% Organic content
18	15 Nov 77	Bulk		20				3.3	
		> 125μ	0.4	< 41	16	0.4	68	17.6	
		> 105μ	0.2	< 40	9	0.2	24	17.1	
		> 88μ	0.4	< 30	12	0.3	64	15.6	
		> 63μ	1.2	< 14	17	0.5	103	8.3	8.2
		< 63μ	28.5	26	771	20.5	861	2.9	4.0
		< 16μ	46.4	29	1400	37.2	1330	2.7	5.5
		< 8μ	12.8	21	280	7.4	381	2.9	
		< 4μ	10.1	120	1260	33.5	424	4.0	
		Sum	100.0			100.0			
42	1 Nov 77	Bulk		25				3.2	
		> 125μ	0.4	350	262	5.0	135	18.0	24.3
		> 105μ	0.2	270	68	1.3	32	12.6	
		> 88μ	0.3	130	64	1.2	59	12.2	
		> 63μ	0.7	41	51	1.0	207	16.7	20.5
		< 63μ	32.7	24	1340	25.3	1590	2.9	4.0
		< 16μ	34.4	37	2160	41.0	1740	3.0	5.4
		< 8μ	17.7	24	722	13.7	1460	4.9	9.2
		< 4μ	12.1	23	475	9.0	1210	5.9	10.8
		< 2μ	1.5	53	131	2.5	179	7.2	7.9
		Sum	100.0			100.0			
63	4 Nov 77	Bulk		73				6.4	
		> 125μ	4.0	1760	7390	35.2	1150	27.3	28.5
		> 105μ	0.8	440	348	1.6	302	38.2	31.1
		> 88μ	1.6	300	489	2.3	473	29.0	26.0
		> 63μ	4.0	42	173	0.8	555	13.5	10.7
		< 63μ	71.5	97	7210	34.3	3660	4.9	6.3
		< 16μ	7.5	200	1550	7.4	424	5.5	
		< 8μ	5.2	95	2730	13.0	307	5.7	
		< 4μ	5.4	200	1130	5.4	341	6.0	
		Sum	100.0			100.0			
63A	4 Nov 77	Bulk		2770				15.0	
		> 125μ	14.5	1390	10400	9.3	4490	59.9	
		> 105μ	2.7	760	1070	1.0	318	22.6	
		> 88μ	4.2	2180	4750	4.2	322	14.8	9.0
		> 63μ	13.0	35	234	0.2	369	5.5	2.2
		< 63μ	21.9	3670	41300	36.7	1040	9.3	12.7
		< 16μ	24.7	1020	12900	11.5	1090	8.6	
		< 8μ	11.2	4480	25900	23.0	731	12.6	
		< 4μ	7.8	3960	15800	14.1	542	13.6	
		Sum	100.0			100.0			

Notes for Table 4:

[1]Percent of sample total weight, etc., which is contained in size fraction.

[2]Percent of fraction which is carbon.